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LISTS OF SPECIES

Survey of large and medium-sized terrestrial mammals in the Serra do Brigadeiro State Park, Minas Gerais, Brazil

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ABSTRACT: The aim of this study was to survey the species of large and medium-sized terrestrial mammals occurring at Serra do Brigadeiro State Park (SBSP). Data was compiled from two studies carried out in 2008. Data was collected through sand plots and camera traps. Thirteen species were recorded, one that had not been registered before (*Leopardus wiedii*) and one exotic (*Canis lupus familiaris*). Species richness estimate for camera trapping was 13.53±1.75. For the sand plots, estimate was lower (9±1.73 species). The low number of inventories focusing on large and medium-sized terrestrial mammals in the Mantiqueira region of the Atlantic forest and the presence of the domestic dogs within the Park limits emphasizes the need for monitoring programs to identify the major threats to preserved areas in the region.

INTRODUCTION

In Brazil, there are about 701 known mammal species, making it the most diverse country worldwide in regards to mammals (Paglia *et al*. 2012). Of those, 83 mammals are considered large and medium-sized (mammal species with > 1.5 kg of body weight, excluding the order Primates), and 15 of the 83 species (18.1%) are included in the State, National or International lists of endangered species (Reis *et al*. 2011). The State of Minas Gerais is estimated to harbor 46% of the mammalian species of small, large and medium-sized of Brazil (Machado *et al*. 2005; Fundação Biodiversitas 2007).

Inventories in protected areas are needed and should be encouraged, because they serve as an assessment of biodiversity in more preserved areas. The production of species lists is crucial for the establishment of conservation strategies, both for species and habitats. This study presents a list of large and medium-sized terrestrial mammals in one of the few protected areas of Atlantic forest of Minas Gerais State larger than 10,000 ha (Fundação Biodiversitas 2007) and considered important for conservation of the biome in the State of Minas Gerais, as it is located in the biodiversity corridor of Caparaó National Park (Lessa *et al*. 2006): *Serra do Brigadeiro* State Park.

MATERIALS AND METHODS

Study Area

Serra do Brigadeiro State Park (hereafter SBSP) has an area of 14,984 ha and is located in the State of Minas Gerais, Brazil (42°40'20'' W and 20°33'00'' S – Figure 1).

SBSP is part of the Mantiqueira Mountains between the valleys of Carangola, Gloria and Rio Doce. Altitudes range from 860 m to 1,985 m above sea level. The climate of the region presents two seasons: wet, from October to March, and dry, from April to September. The average annual precipitation is approximately 1,500 mm and the average temperature 23°C (Köeppen 1948).

Vegetation of SBSP is composed of semideciduous seasonal forest and ombrophilous rainforest (Caiafa 2005) belonging to the Atlantic Rainforest domain. There are also Altitude Fields (Non-forested vegetation that occurs in the higher regions of eastern Brazil. Important centers of endemism of the flora), which occupy isolated plateaus and cliffs on rocky outcrops above 1,600 m. The forested areas show varying degrees of human interference, caused by the removal of natural forest cover in the late 1950s and throughout the 1960s (Caiafa 2005).

Data Collection

Data collection was based on two studies of mammals carried out in 2008. The methodologies, sampling period and regions within SBSP were different between the two studies: (1) in the first study, we sampled mammals for 12

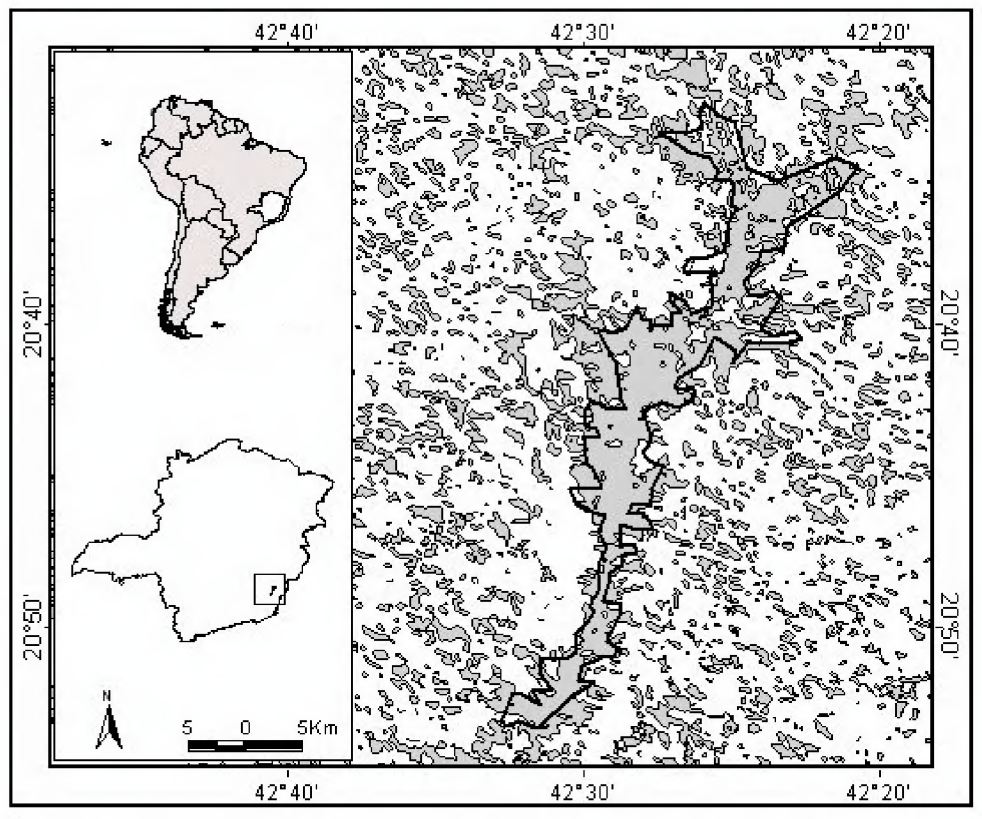

FIGURE 1. Location of the Serra do Brigadeiro State Park and its environment forest remnants, Minas Gerais State, Brazil.

months with camera-traps, in the northern region of the park. We used eight camera-traps (Trapa ®-camera, 35 mm film model), and rotated them between three areas. Each area had eight locations with one camera, at a distance of 350 m from one another. Camera-traps remained active 24 hours per day for 30 consecutive days in each area. The total effort was 2,880 trap*days, and the effort per area was 960 trap*days (see details in Nunes *et al.* (2012); (2) in the second study, we placed sand-plots in the central region of the park for 10 months. We installed two sampling grids, adapted from Scoss *et al*. (2004) in two areas near the Park headquarters. Each grid consisted of three transects of 300 m each, parallel to the highway. The first transect was 10 m away from the highway, and the other two were 80 m and 150 m away, respectively. Each transect had ten 1 x 1-m plots, with an approximate distance of 30 m between each plot. In total, there were 600 sand-plots and the total effort was 1,800 sand-plots*day. We used baits as attractant.

Both data sets followed the taxonomic nomenclature suggested by Wilson and Reeder (2005).

Data Analysis

For each sampling method, predicted species richness was estimated using the 1st order Jackknife procedure (Heltshe and Forrester 1983) through the software Estimate S version 6.0b1 (Colwell 2000). For camera-traps, photos of the same species taken within a 24-hour interval in a given station and for which it was not possible to identify natural marks (stripes, spots, moles, etc) were grouped together as one single record. For sand-plots, footprints of the same species in a given sand-plot in a period of 24-hours represented only one independent record. To avoid recounting old tracks, plots were cleared at every check.

To determine the conservation status of the recorded species, the threat category was verified according to the Red Book of Endangered Species of the Fauna of Minas Gerais (COPAM 2010), the List of Endangered Brazilian Fauna (Machado *et al*. 2008), and the Red List of the International Conservation Union (IUCN 2011).

Results and Discussion

We recorded 13 species of large and medium-sized terrestrial mammals at *Serra do Brigadeiro* State Park, from the Orders: Carnivora (N = 8), Artiodactyla (N = 2), Rodentia (N = 1), Lagomorpha (N = 1), and Didelphimorphia (N = 1) (Table 1). Seven species were recorded exclusively by camera-traps in the northern region of the park (Figure 2), three species were recorded exclusively in the sand-plots, in the central region of the park (Figure 3) and three species were recorded by both methods in both areas (north and central). Camera trapping presented an estimated richness of 13.53 ± 1.75 (mean ± 1 Jackknife confidence interval). Sand-plots presented an estimated richness of 9.00 ± 1.73 species. Species accumulation curve for the sand plots showed a tendency for stabilization, which was less evident for the camera-trap curve (Figure 4). Therefore, greater effort for the camera traps could have led to more species records.

Four of the recorded species are included in some category of threat or of interest for conservation. Collared peccary (*Pecari tajacu*) is classified as Vulnerable in Minas Gerais (COPAM 2010). Ocelot (*Leopardus pardalis*), margay (*Leopardus wiedii*), and puma (*Puma concolor*) are considered Vulnerable both in Minas Gerais (COPAM 2010) and in Brazil (Machado *et al*. 2008). And margay (*L. wiedii*) is listed in the Global Red List of Endangered Species as Near Threatened (IUCN 2011).

We recorded one native species (*L. wiedii*), and one exotic species (*Canis lupus familiaris*) that had not been recorded in the Management Plan (Lessa *et al*. 2006). *L. wiedii* was recorded in the extreme north of the park through camera traps (Figure 2). It is a small cat, highly adapted to life in the trees and very agile on the ground, being considered by some authors as an animal with a scansorial habit (Oliveira 1994, Fonseca *et al*. 1996). It is a forested species which can be found in gallery forests in the Brazilian Cerrado (Emmons and Feer 1997; Machado *et al*. 2005). Some of the main threats to this species are the effects of fragmentation and poaching for fur trade (Indrusiak and Eizirik 2003; Oliveira and Cassaro 2005).

Records of *C. lupus familiaris* were made through camera traps in the northern region of the Park, and through observation and footprint records on roads and trails in the central region (Figures 2 and 3). Domestic dog was the most abundant species in central SBSP.

Dogs recorded in conservation units are often associated with edge effects (Galetti and Sazima 2006; Srbek-Araujo and Chiarello 2008; Beisiegel, 2009). Although some authors consider that dogs are inefficient predators (Kay 1998), others assert that these animals prey on small and medium-sized animals (Galleti and Sazima 2006). In fact, Oliveira and colleagues (2008) reported a case of an individual of *Sapajus nigritus* being attacked by feral dogs inside the SBSP limits. Domestic dogs can also be vectors of diseases such as rabies, leishmaniasis, distemper, and parvovirus that could compromise wild populations (Cleveland *et al*. 2000). Finally, domestic dogs compete directly with the local wildlife for resources and they may displace native species from their habitats (Negrão and Valladares-Pádua 2006).

Some species that are common in surveys of large and medium-sized mammals were not registered in this study, such as the armadillos *Dasypus novemcinctus* and *Euphractus sexcinctus* (Cingulata – Chiarello 2000). The absence of the two armadillo species may be associated with the sampling methodologies used this study, as it is more common to record armadillos through their indirect records, such as burrows, than through footprints or direct observations (Scoss *et al*. 2004). Besides the two armadillo species, we also expected to register the maned-wolf (*Chryscyon brachyurus*, Carnivora), as there are records of this species in fragments near to the region of SBSP (Prado *et al*. 2008).

There is no published information on species of large and medium-sized mammals in other protected areas that make up the Mantiqueira Mountains of Minas Gerais State. Yet, in Itatiaia National Park (Rio de Janeiro State), which is part of the southern range of the Mantiqueira ridge, Geise *et al*. (2004) reported 27 species of large mammals, 16 of which were not recorded in the present study at SBSP. Also, in the extreme north of Mantiqueira Mountain range (Caparaó National Park, Rio de Janeiro State), Ruschi (1978) recorded 25 species of large mammals, 13 that

were not present in our survey of SBDP (Table 2).

At *Rio Doce* State Park (RDSP), which is the largest fragment of Atlantic forest in Minas Gerais State (36,000 ha), Scoss and colleagues (2004) recorded 16 species of large and medium-sized mammals, three of which (*Tapirus terrestris*, *Panthera onca*, *Dasyprocta sp*) had no records in our study. In the forest zone of a mining region near SBSP areas, Prado *et al.* (2008) also recorded a greater number of species of large and medium-sized mammals, some of which not recorded at SBSP (*Tamandua tetradactyla*,

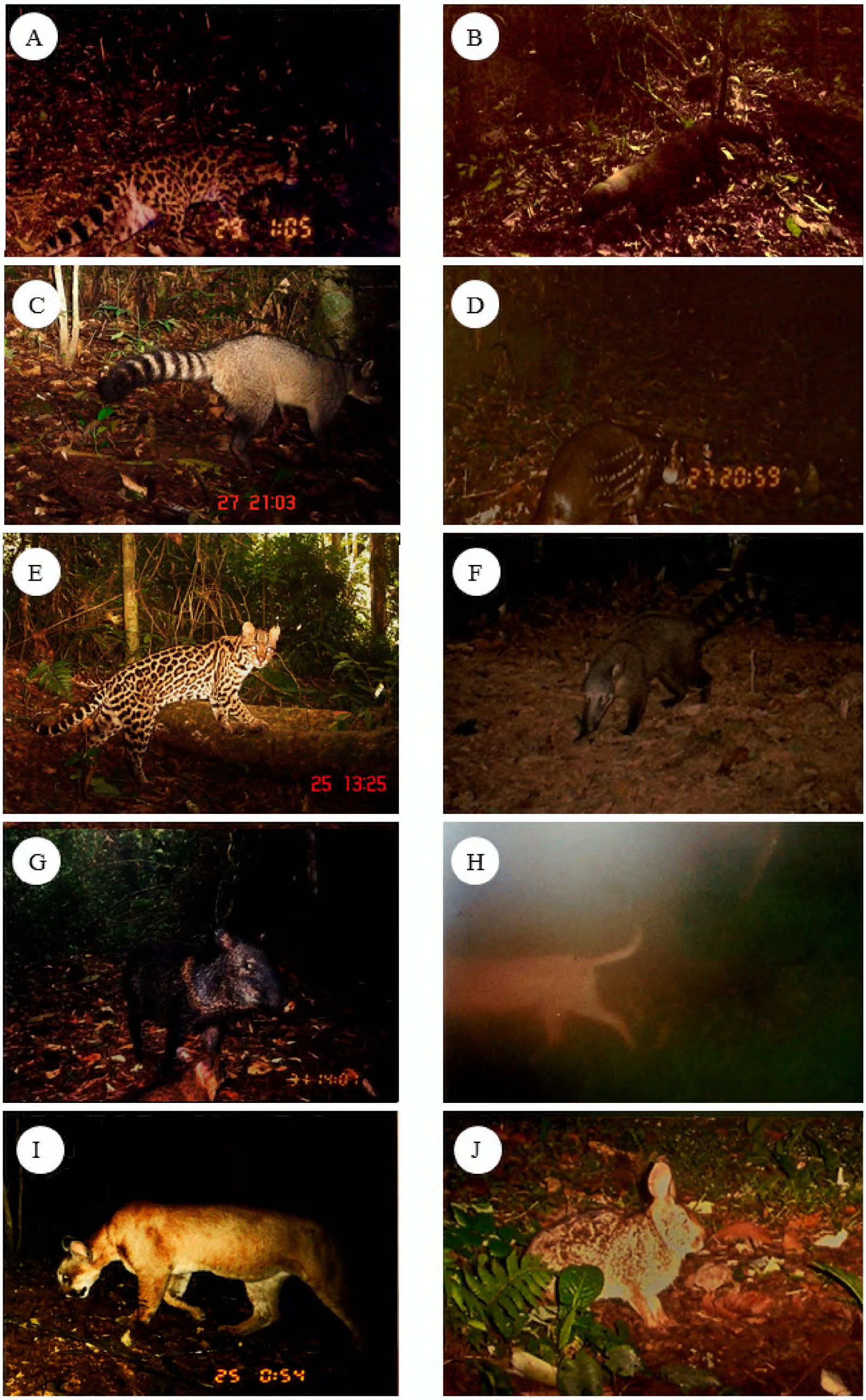

Figure 2. Native mammal species identified through camera traps at Serra do Bridageiro State Park, Atlantic Rainforest, southeastern Brazil. A: *Leopardus wiedii*; B: *Eira barbara*; C: *Procyon cancrivorus*; D: *Cuniculus paca*; E: *Leopardus pardalis*; F: *Nasua nasua*; G: *Pecari tajacu*; H: *Canis lupus familiaris*; I: *Puma concolor*; J: *Sylvilagus brasiliensis*;

Table 1. Category of threat and the list of species of terrestrial mammals of medium and large of Serra do Brigadeiro State Park. Sampling methods: (Fp) footprints and (Ct) camera traps. VU – vulnerable, NT – near threatened, LC – least concern. Categories of threat of extinction, according to the global list of IUCN (2001), the national list (BR) Machado *et al*. (2008) and Minas Gerais (MG) COPAM (2010).

TAXON	COMMON NAME	CATEGORY OF THREAT	RECORD
DIDELPHIMORPHIA			
Family Didelphidae			
Didelphis aurita (Wied-Neuwied, 1826)	Brazilian Common Opossum	LC	Fp
ARTIODACTYLA			
Family Cervidae			
Mazama sp. (Erxleben, 1777)	Red Brocket Deer	LC	Fp
Family Tayassuidae			
Pecari tajacu (Linnaeus, 1758)	Collared peccary	LC^{IUCN};LC^{BR};VU^{MG}	Ct
CARNIVORA			
Family Canidae			
Canis lupus familiaris (Linnaeus, 1758)	Domestic Dog	LC	Fp, Ct
Cerdocyon thous (Linnaeus, 1766)	Crab-eating Fox	LC	Fp
Family Procyonidae			
Procyon cancrivorus (Cuvier, 1798)	Crab-eating Raccoon	LC	Fp, Ct
Nasua nasua (Linnaeus, 1766)	South American Coati	LC	Ct
Family Mustelidae			
Eira barbara (Linnaeus, 1758)	Tayra	LC	Ct
Family Felidae			
Puma concolor (Linnaeus, 1771)	Puma	LC^{IUCN};VU^{BR};VU^{MG}	Ct
Leopardus pardalis (Linnaeus, 1766)	Ocelot	LC^{IUCN};VU^{BR};VU^{MG}	Ct
Leopardus wiedii (Schinz, 1821)	Margay	NT^{UCN};VU^{BR};VU^{MG}	Ct
RODENTIA			
Family Cuniculidae			
Cuniculus paca (Linnaeus, 1766)	Spotted Paca	LC	Fp, Ct
LAGOMORPHA			
Family Leporidae			
Sylvilagus brasiliensis (Linnaeus, 1758)	Brazilian Rabbit	LC	Ct

Figure 3. Native mammal species identified through footprints from sand-plots at Serra do Bridageiro State Park, Atlantic Rain Forest, Southeastern Brazil. A: *Cuniculus paca*; B: *Procyon cancrivorus*; C: *Canis lupus familiaris*; D: *Mazama* sp; E: *Cerdocyon thous*; F: *Didelphis aurita.*

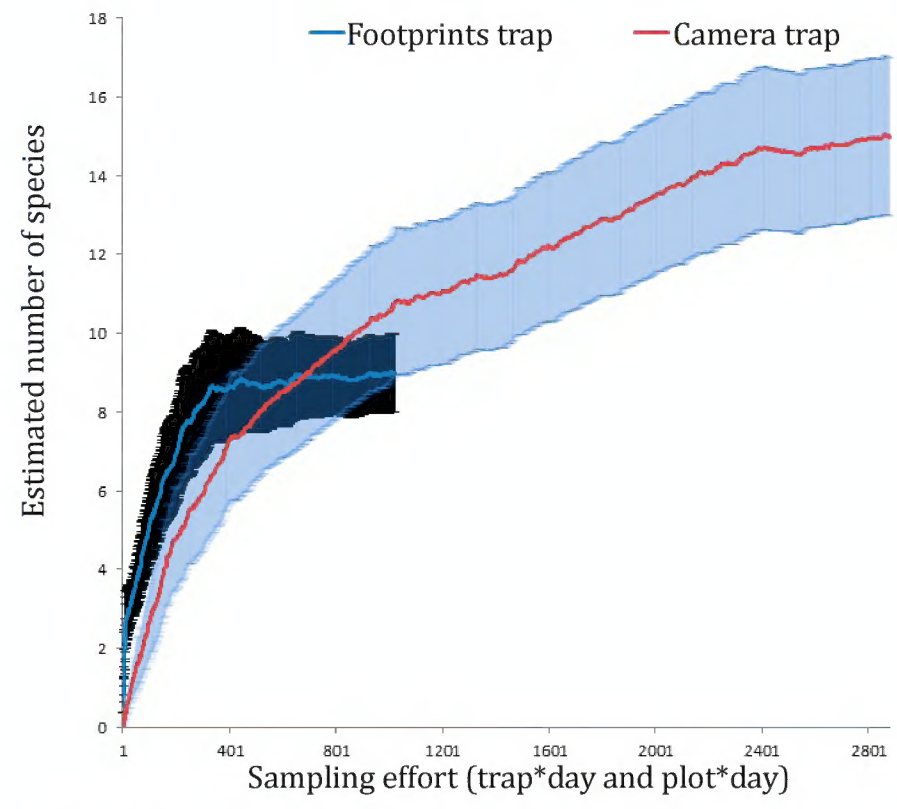

Figure 4. Estimated richness (Jackknife 1st order) of terrestrial mammals of medium and large size through two sampling methodologies (camera-traps and sand-plots) at Serra do Brigadeiro State Park.

D. novemcinctus, *E. sexcinctus*, *C. brachyurus*, *Galicts cuja*, *Leopardus tigrinus*, *Hydrochoerus hydrochaeris*) (Table 2).

Desengano National Park (DNP) and Bocaina National Park (BNP) are protected that are relatively close to the *Zona da Mata mineira*, located in the western state of Rio de Janeiro. Present vegetation and terrain with altitudes above 1.800 m, similar to peaks and scarpas found in *Serra do Brigadeiro* State Park. Furthemore, both areas have a

weather similar to that observed for the SBSP. Delcielos *et al*. (2012) have a total 16 species for BNP, however, seven species were not record the areas of SBSP. Modesto *et al*. (2008), also report the same richness observed for DNP, and the same number of species not listed in this study (Table 2).

Among the genera listed in the aforementioned studies, eight (*Panthera*, *Dasypus*, *Euphractus*, *Cabassous*, *Mazama*, *Tayassu*, *Tapirus*, *Dasyprocta*) suffer from human disturbance, especially hunting activity (Redford 1992, Peres 2006) and the absence of these species in *Serra do Brigadeiro* State Park may be related to this activity. The absence of more sensitive large mammals, such as *Tapirus terrestris* and *Panthera onca*, can also be attributed to the size of the park, its thinner format (with a small width extension) and disturbance level.

Final Remarks

Through this study, we increased the records of large and medium-sized terrestrial mammals in the *Serra do Brigadeiro* State Park, emphasizing its importance for the purposes of conservation units in the state of Minas Gerais. The presence of an exotic species within park limits suggests negative impacts on the community of native mammals of the park, although no systematic studies have been carried out to confirm this hypothesis.

Maintaining the populations of large and medium-sized mammals listed in this study is extremely important, especially those that are under extinction threat in Minas Gerais State and Brazil as whole. Findings from this study emphasize the need for studies and efforts directed towards the conservation of large and medium-sized mammals throughout the Mantiqueira Mountains.

Table 2. List of species occurring in protected areas near the SBSP, but who did not have records for the Serra do Brigadeiro State Park. INP – Itatiaia National Park, BNP – Bocaina National Park, DNP – Desengano National Park, CNP – Caparaó National Park, RDSP – Rio Doce State Park, RSTEE – Research Station, Training and Environmental Education.

TAXON	COMMON NAME	RECORD
CINGULATA		
Family Dasypodidae		
Dasypus novemcinctus (Linnaeus, 1758)	Nine-banded Armadillo	INP, BNP, DNP, RSTEE
Euphractus sexcinctus (Linnaeus, 1758)	Six-banded Armadillo	BNP, CNP, RSTEE
Dasypus septemcinctus (Linnaeus, 1758)	Brazilian Lesser Long-nosed Armadillo	INP, DNP
Cabassous tatouay (Desmarest, 1804)	Greater Naked-tailed Armadill	INP, DNP
PILOSA		
Family Myrmecophagidae		
Tamandua tetradactyla (Linnaeus, 1758)	Southern Tamandua	INP, BNP, CNP, RSTEE
Myrmecophaga tridactyla (Linnaeus, 1758)	Giant Anteater	INP
ARTIODACTYLA		
Family Cervidae		
Mazama americana (Erxleben, 1777)	South American Red Brocket	INP, CNP
Mazama gouazoubira (G. Fischer [von Waldheim], 1814)	Gray Brocket	CNP
Family Tayassuidae		
Tayassu pecari (Link, 1795)	White-lipped Peccary	BNP, DNP, CNP
PERISSODACTYLA		
Family Tapiridae	Tayra	
Tapirus terrestris (Linnaeus, 1758)	South American Tapir	CNP, RDSP
RODENTIA		
Family Dasyproctidae		
Dasyprocta azarae (Lichtenstein, 1823)	Azara's Agouti	RDSP
Dasyprocta leporina (Linnaeus, 1758)	Red-rumped Agouti	BNP, DNP, CNP, RDSP
Family Cavidae		
Hydrochoerus hydrochaeris (Linnaeus, 1766)	Capybara	INP, RSTEE
Family Erethizontidae		
Coendou insidiosus (Olfers, 1818)	Brazilian Porcupine	INP
Coendou villosus (F. Cuvier, 1823)	Prehensile-tailed porcupine erizo	BNP
CARNIVORA		
Family Canidae		
Chrysocyon brachyurus (Illiger, 1815)	Maned Wolf	INP, RSTEE
Family Felidae		
Leopardus tigrinus (Schreber, 1775)	Oncilla	INP, BNP, DNP, CNP, RSTEE
Panthera onca (Linnaeus, 1758)	Jaguar	INP, CNP, RDSP
Puma yagouaroundi (É. Geoffroy Saint-Hilaire, 1803)	Jaguarundi	INP
Family Mustelidae		
Conepatus semistriatus (Boddaert, 1785)	Striped Hog-nosed Skunk	INP
Galictis cf. *cuja* (Molina, 1782)	Lesser Grison	
Lontra longicaudis (Olfers, 1818)	Neotropical Otter	NIP, CNP, RSTEE
Family Procyonidae		
Potos flavus (Schreber, 1774)	Kinkajou	DNP

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